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ERGOT

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ERGOT
of grains and grasses

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WHAT IS ERGOT?

Ergot is best known as a disease of rye but it also affects most other grains and grasses. The causal fungus, *Claviceps purpurea* (Fr.) Tul., infects the flowers, prevents seeds from developing, and replaces many kernels with hard, seed-like fungus bodies called sclerotia. The disease causes losses in the following ways.

- When marketed, grain or seed shipments containing more than a certain concentration of ergot sclerotia are downgraded or rejected.
- Ergot sclerotia in forage grasses, feed, or flour may cause a debilitating and sometimes fatal poisoning of animals, poultry, and humans.
- Yield is reduced because ergot-affected heads produce fewer kernels than healthy ones.

Plants affected by ergot have been found in every province of Canada. In some years the disease is severe in certain areas. The prevalence of the disease depends chiefly upon the amount of inoculum produced by overwintered sclerotia and upon weather conditions during flowering of grains and grasses.

RECOGNIZING ERGOT

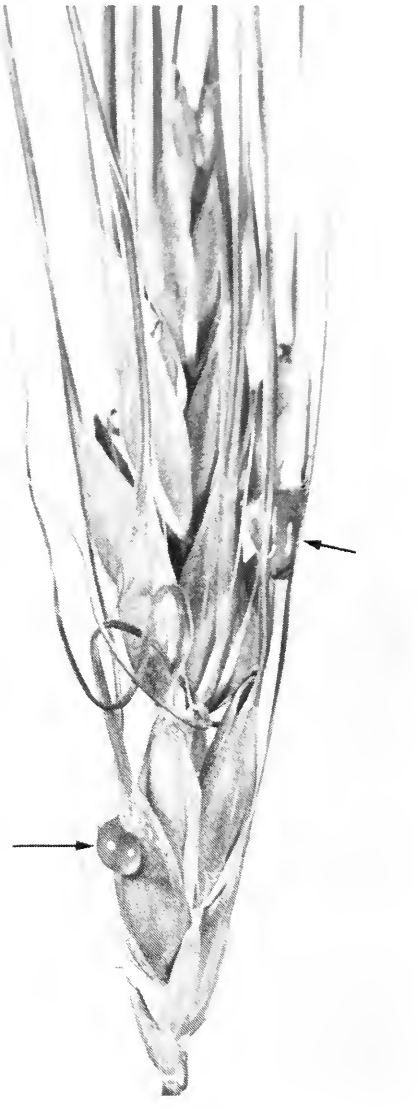
Affected plants may be detected as early as the flowering stage, but the disease is most easily recognized by the dark sclerotia in mature heads. The three main symptoms of the disease are honeydew, sclerotia, and sterility.

Honeydew

During flowering, droplets of a sugary liquid containing fungus spores collect on the surface of infected florets. This deposit, called honeydew, attracts insects. Later, the accumulation of dust and pollen in the sticky exudate gives the affected heads a dirty appearance.

Sclerotia

In one or more of the infected florets the fungus usually continues to develop and, by maturity, forms within the floral bracts a hard, purplish black structure called a sclerotium or ergot body. The size and shape of the sclerotia vary with the host: in some grasses they are inconspicuous and about the same size as the seed, whereas in rye, sclerotia are often horn-shaped and several times

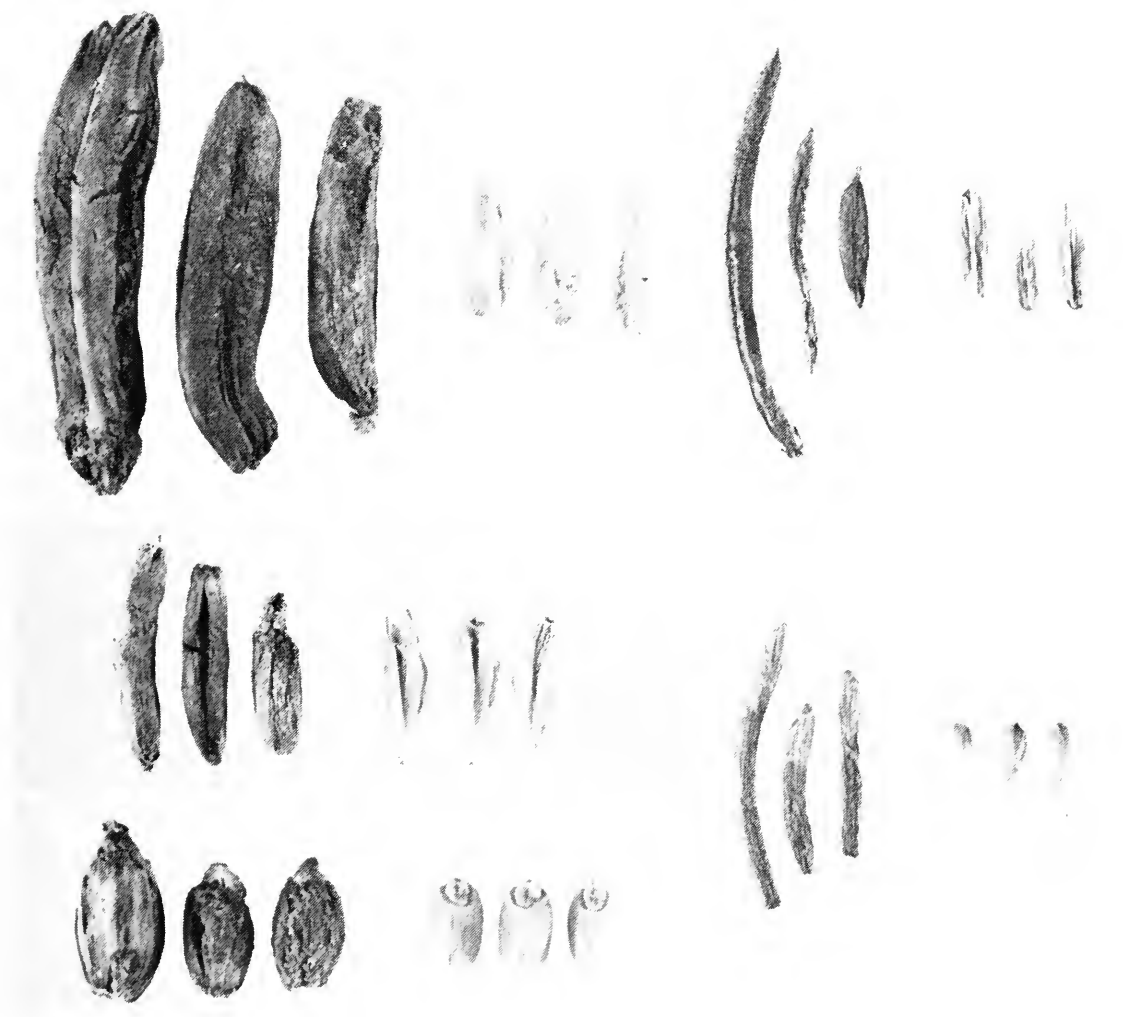


Conidia of the ergot fungus are exuded from infected florets in droplets of honeydew (shown here on barley). These secondary spores are carried to healthy flowers by splashing rain and by insects that are attracted to the sugary honeydew.

bigger than the kernels. In harvested seed, ergot bodies are usually conspicuous because of their color; pieces of broken sclerotia may be distinguished from other debris by their dark outer rind and grayish white interior. Fragments of ground-up sclerotia in flour or feed are more difficult to detect, and microscopic, chemical, or physiological tests may be needed to determine their presence.

Sterility

In ergot-affected heads many florets do not produce seed. Often sclerotia develop in only a few of the florets, while others remain sterile and empty of both seed and sclerotia. Sometimes in grasses that mature quickly the only symptoms apparent are honeydew and sterile florets.



Ergot sclerotia (at left in each photo) can be distinguished from the seeds of cereals and grasses by their size, shape, and color. (Photos are slightly enlarged.)

SUSCEPTIBLE PLANTS

Most native grasses and all varieties of cultivated grains and grasses grown in Canada are susceptible to ergot. Among cultivated crops, rye and triticale, a newly developed grain derived from rye and wheat, are most often ergotized; barley is also commonly affected; and durum is more often affected than common wheat.

Grains in which sterility occurs, such as triticale, and cross-pollinated hosts, such as rye and most grasses, are more likely to become infected by the ergot fungus because their florets are open longer than those of fertile, self-pollinated hosts, thereby providing prolonged access to ergot spores. Oats is seldom affected by ergot, probably because the young ovary is protected by tightly enclosing floral bracts. Forage grasses are most seriously damaged by ergot when they are grown for seed production.

Above left Sterility greatly increases the chances of ergot infection. The heads of triticale *(left)* and of a male-sterile line of wheat *(right)* are severely affected.

Above right Cross-pollinated grains and grasses, such as rye *(left)* and timothy *(right)*, are often affected by ergot.

Grasses on which ergot has been reported in Canada include species of *Agropyron* (quack grass, crested wheat grass, slender wheat grass, western wheat grass), *Agrostis* (redtop), *Avena* (wild oats), *Bromus* (fringed brome, smooth brome), *Calamagrostis* (blue-joint, marsh reed grass, northern reed grass), *Cinna* (slender wood grass), *Dactylis* (orchard grass), *Deschampsia* (tufted hair grass), *Elymus* (Canada wild rye, giant wild rye, blue wild rye, hairy wild rye), *Festuca* (meadow fescue, red fescue, rough fescue), *Glyceria* (floating grass, fowl manna grass), *Hierochloë* (sweet grass), *Hordeum* (foxtail barley), *Koeleria* (June grass), *Lolium* (Italian rye grass, perennial rye grass, Persian darnel), *Phalaris* (reed canary grass), *Phleum* (timothy, alpine timothy), *Poa* (blue grasses),

Scolochloa (spangletop), *Setaria* (yellow foxtail), *Spartina* (alkali cord grass), *Stipa* (green needle grass, porcupine grass), *Torreyochloa* (Torrey's manna grass).

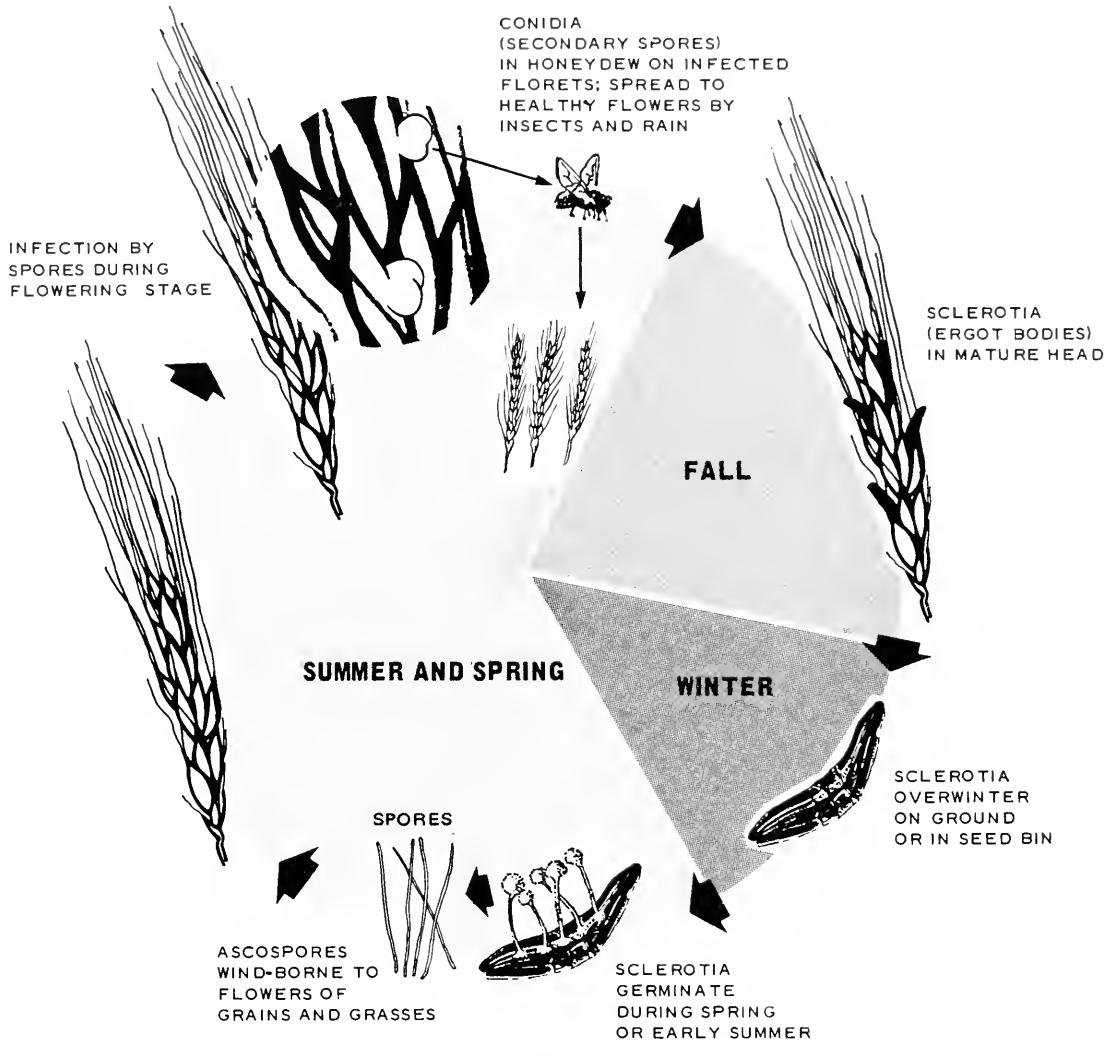
Wild rice (*Zizanea aquatica L.*) and some of the grasslike rushes (*Juncus* spp.) and sedges (*Carex* spp., *Eleocharis* spp.) are also affected by ergot in Canada. However, the species of *Claviceps* that cause ergot in those plants do not affect the grains and grasses referred to in this publication.

DISEASE CYCLE

The fungus survives from one season to the next by means of the hard sclerotia produced in a preceding crop or in grasses in headlands, roadsides, or ditches. Sclerotia may also be introduced into a field by planting infested seed. When conditions of moisture and temperature are favorable, sclerotia germinate, producing slender stalks up to 4 cm long that extend the spore-producing heads of the fungus above debris or a shallow covering of soil. Ascospores released from the tiny heads are carried on air currents. Germ tubes from spores that are deposited in an open floret of a susceptible plant penetrate the ovary wall and the fungus mycelium grows throughout the ovary, killing the host tissues. About 5 days after infection the sticky honeydew, containing thousands of conidia, or secondary spores, collects on the surface of infected florets. Conidia are carried to healthy florets by contact, rain, and numerous insects that are attracted to the sugary honeydew. Conidia are disseminated as long as flowering continues. As the crop matures, the fungus continues to grow within many infected florets, replacing the ovule, and eventually forming the sclerotium by which it survives the winter.

CONDITIONS FAVORING ERGOT INFECTION

The incidence of ergot varies greatly from year to year in cereal crops, but observations in the Prairie Provinces indicate that in most years ergot may readily be found in grasses growing in headlands and along roadsides. Overwintered sclerotia from such grasses and honeydew produced early in the growing season in infected florets of these grasses undoubtedly supply much of the primary inoculum for infection of cultivated crops. Studies have shown that isolates of the ergot fungus collected from more than 30 grass species in Canada can infect rye, wheat, and barley.

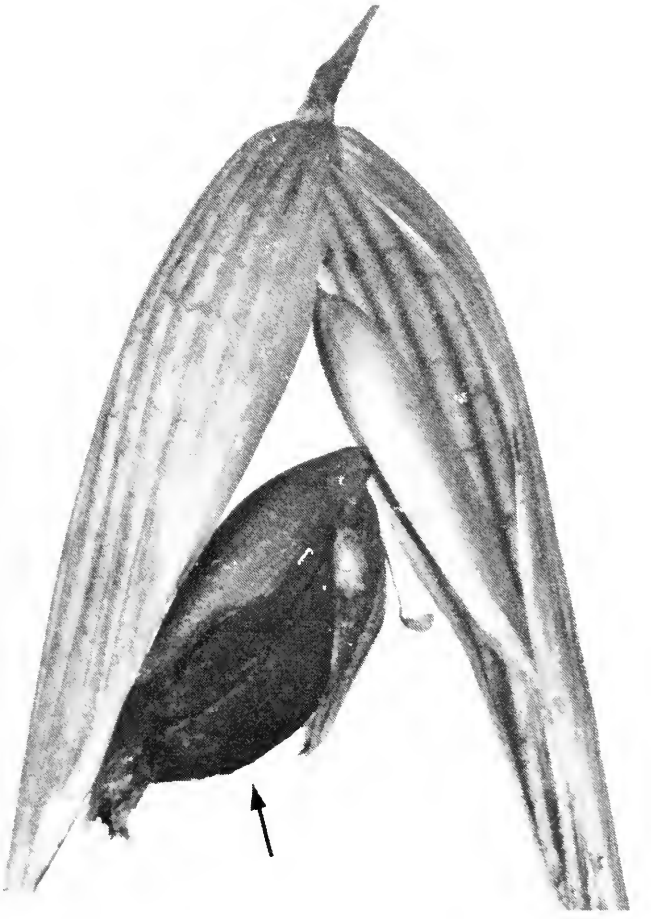


Life cycle of the ergot fungus.

Because of their nearness to grasses, and because insect activity is usually greatest at the edges of fields, grain plants at the field margins are often more severely affected by ergot than those in the interior.

Ergot is usually most prevalent in seasons when moisture is readily available at the soil surface during spring and early summer and when showery weather prevails during flowering of grains and grasses. Sclerotia require moisture to germinate, and frequent showers stimulate the release of ascospores and aid the spread and germination of conidia.

Cloudy, wet, or cold weather during flowering delays pollination and extends the period of greatest susceptibility. Experiments with barley have shown that the ovary is more resistant to infection after it has been fertilized.



Sclerotium of *Claviceps purpurea* in an oat floret. Ergot seldom occurs on oats.

Unfortunately several modern farming practices, including combine harvesting, shallow cultivation, broadcast seeding, and the seeding of mixed grains, tend to increase the incidence of ergot. Many sclerotia fall from the grain heads at maturity, and more are in the straw and chaff left on the field after combining. If sclerotia are only lightly covered by surface tillage or by shallow seeding, they are ideally situated to germinate and produce ascospores. Light seeding rates, shallow seeding, and the use of mixtures of seeds of varying maturity often result in uneven stands and late tillering, thereby increasing the chances of ergot infection.

Untimely or excessive applications of herbicides to cereal crops may result in injury to the plants. Damage that results in open-floret sterility or delayed maturity favors ergot infection.

CONTROLLING THE DISEASE

Seed treatment with chemicals does not control ergot, and resistant varieties of cereals and grasses are not yet available.

Therefore control methods must be designed to limit the availability of fungus spores and to produce crops of uniformly developing plants that flower at the same time and for as short a period as possible.

To control the disease it is important to use ergot-free seed and to follow cultural practices that reduce the incidence of ergot in native and volunteer grasses and its spread to cultivated crops.

Sanitation

To prevent or reduce the formation of honeydew and sclerotia in volunteer hosts, mow headland and roadside grasses at or before heading.

If ergot is a problem in pastures or on range land, grasses in low, wet places should be cut or grazed heavily before they flower.

In areas where ergot is prevalent, harvest hay crops at the heading stage.

When harvesting fields showing ergot infection at the edges, separate the seed collected during the first few rounds of the combine from the rest of the grain. If grain from the outside swaths is heavily infested with ergot bodies, destroy it. Mixing heavily infested seed with the bulk of the crop could result in the degrading or rejection of the entire lot. Sometimes it may be practical to have infested grain cleaned.

Modern seed-cleaning methods can remove many sclerotia. However, there are extra charges for the special handling and cleaning of infested grain at terminal elevators. Some country elevators do not accept delivery of grain that is off-grade because of ergot. For small seed lots, almost all sclerotia can be removed by flotation in a 20% salt solution (20 kg of common salt in 100 L of water). After thorough stirring the sound seeds sink, but the sclerotia float to the surface and can be skimmed off. Then the grain should be washed and dried thoroughly.

Bury the sclerotia by plowing or deeply cultivating fields in which ergot has been present. When sclerotia are covered by 5-8 cm of soil, the spore-bearing stalks are unable to reach the surface to discharge their ascospores.

If you must sow ergot-infested seed, plant it at least 6 cm deep. Holding such seed for 2 or 3 years before seeding reduces considerably the number of viable sclerotia.

Uniform stands

Use good-quality seed of high germinability, and seed at an even depth and at an adequate rate to produce a stand of plants that develop uniformly and flower at the same time.

Because florets produced by late tillers are particularly apt to become infected, do not seed mixed grains in areas where ergot has been a problem; do not plant early- and late-maturing crops close to each other.

Avoid herbicide injury by selecting chemicals that are suitable for your crop and location. Apply the herbicide when the crop is at the growth stage recommended on the herbicide label and use the minimum rate needed to effectively control your problem weeds. Contact your agricultural representative or nearest Agriculture Canada research station for up-to-date recommendations.

Rotation

Because ergot sclerotia survive in the soil for at least a year, do not plant a cereal or grass after an ergot-affected crop; it is particularly important not to plant rye or triticale after an infected crop or in successive years in the same field. If a grain must be planted after a cereal or grass, oats is the most suitable. If ergot is a problem in crops of spring rye, try planting fall rye instead. The earlier-flowering fall rye may escape infection from conidia produced on neighboring grasses.

REGULATIONS DEALING WITH ERGOT CONTENT OF SEED AND FEED

Seed

The Canada Seeds Act specifies maximum numbers of ergot sclerotia permitted in the pedigreed and commercial grades of wheat, barley, oats, rye, triticale, and grasses sold in Canada. For example, seed of all No. 1 grades of common wheat and durum wheat and Foundation No. 1 and Registered No. 1 grades of barley and oats may contain only one ergot sclerotium per kilogram of seed. All No. 2 grades of wheat and Foundation No. 2 and Registered No. 2 grades of barley and oats may contain up to eight ergot sclerotia per kilogram. Certified No. 1 and Canada No. 1 barley and oats may contain two ergot sclerotia per kilogram, whereas Certified No. 2 and Canada No. 2 may contain six ergot sclerotia per kilogram. In rye and triticale, the limits are two ergot sclerotia per kilogram for Foundation No. 1 and Registered No. 1, and 20 per kilogram for Foundation No. 2 and Registered No. 2; for Certified No. 1 and No. 2 the maximum numbers are 6 and 30, and for Canada No. 1 and Canada No. 2 rye and triticale, 10 and 30, respectively. Similar standards apply to the various grades of grass seed sold in Canada: the maximum permitted in the No. 1 grades is 1.5% and in the No. 2

grades 3.0% by weight. More information on ergot tolerances in seed of cereals and grasses may be obtained from the Seed Section, Plant Products Division, Agriculture Canada, Ottawa, Ont. K1A 0C6.

Commercial grain

Limits on the amount of ergot permitted in cereal and feed grains destined for domestic milling and for export are imposed by the Canadian Grain Commission under authority of the Canada Grain Act. Under present primary tolerances, which apply in the country and upon receipt of the grain at terminal elevators, the highest grades of wheat (No. 1 C.W. Red Spring, Amber Durum, Soft White Spring, and Red Winter, and No. 1 and No. 2 White, Red, and Mixed C.E. Winter) may contain no more than three kernel-sized pieces of ergot sclerotia in a 500 g sample. Lower grades of wheat have primary tolerances ranging up to 0.25% by weight in No. 3 Utility and No. 5 Amber Durum wheats. No. 1 C.W. and C.E. Oats must be free from ergot, whereas No. 1 C.W. and C.E. Six-Row and Two-Row Barley may contain a maximum of 0.05% by weight. No. 1 and No. 2 Feed Oats may contain 0.1%; No. 3 Feed Oats and all feed grades of barley 0.25%. In rye, tolerances are slightly higher, ranging from 0.05% in No. 1 to 0.33% in No. 2 and No. 3. Rye containing more than 0.33% ergot is graded Ergoty; other grains that contain more than 0.25% are graded Sample Account Ergot. All grades of Mixed Grain may contain up to 0.25%, and Sample Feed Grain 0.33% ergot. Screenings are also subject to ergot tolerances: 0.25% for No. 1 Mixed Feed Oats and No. 2 Mixed Feed Oats; and 0.1% for No. 1 and No. 2 Feed Screenings, Uncleaned Screenings, and Refuse Screenings. More information on ergot tolerances in grain may be obtained from the Inspection Division, Canadian Grain Commission, Winnipeg, Man. R3C 3H5.

Feed

In animal and poultry feeds, present requirements in Canada do not permit an ergot content exceeding 0.1% by weight.

ERGOT POISONING

Ergot sclerotia contain several alkaloids that cause poisoning in humans, animals, and birds. Cases of ergot poisoning in humans are now rare, but for years ergotism occurred sporadically in areas of Europe where rye flour was the principal ingredient of bread. Because the alkaloids contained in ergot sclerotia cause contrac-

tion of smooth muscles, ergot has been used medicinally for many years to control bleeding and to induce uterine contractions. In some countries ergot is produced commercially for such purposes.

Because the concentration of alkaloids in sclerotia varies among strains of the fungus, and because animals differ in their tolerance for the poison, it is hard to specify toxic concentrations of ergot. However, a total feed ration containing 0.1% ergot should be regarded as dangerous.

Symptoms

Chronic ergotism is caused by the cumulative effects of the continued eating of small amounts of ergot sclerotia. In animals it usually causes the small blood vessels to contract and reduce blood circulation in the extremities. Lameness of one or more legs is often the first indication of chronic ergotism. Impaired circulation can result in gangrene of the tips of the ears, tail, or lower limbs. The gangrenous portion separates from the normal tissue and may drop off. In sheep ergotism may result in ulceration and necrosis of the tongue and the mucous membrane of the gastrointestinal tract.

Losses in productivity resulting from unthriftiness in steers feeding on ergotized pasture or range grasses or on ergoty grain may often go unrecognized. Feeding trials in Manitoba have shown that cattle receiving as little as 0.1% ergot by weight in high-protein rations are affected more by heat stress than those fed ergot-free grains.

In poultry and other birds, the most easily recognized symptom is dry gangrene of the comb, tongue, and beak; but there is also evidence that the growth of broiler chicks is depressed by low levels of ergot in the diet.

In pregnant animals, especially mares and sows, milk production may be reduced or stopped and the vitality of the newborn reduced. Feeding trials have shown that brood sows fed as little as 0.1% ergot in barley may produce small weak litters and little or no milk. Abortion may be another symptom of ergot poisoning.

Acute ergotism is caused by the ingestion of large amounts of ergot in a short time. Symptoms are nervousness, skin sensitivity, trembling, and uncoordinated movements. In extreme cases, convulsions and death may occur.

Ergot sclerotia may also irritate the digestive system and cause nausea, colic, and diarrhea.

Treatment

If animals are suspected of being affected by ergot, keep them quiet and warm, and make sure no ergot is in their feed. Ask a veterinarian how to treat animals that show symptoms of gangrene or acute poisoning.

CONVERSION FACTORS

Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	x 0.04	inch
centimetre (cm)	x 0.39	inch
metre (m)	x 3.28	feet
kilometre (km)	x 0.62	mile
AREA		
square centimetre (cm^2)	x 0.15	square inch
square metre (m^2)	x 1.2	square yard
square kilometre (km^2)	x 0.39	square mile
hectare (ha)	x 2.5	acres
VOLUME		
cubic centimetre (cm^3)	x 0.06	cubic inch
cubic metre (m^3)	x 35.31	cubic feet
	x 1.31	cubic yard
CAPACITY		
litre (L)	x 0.035	cubic feet
hectolitre (hL)	x 22	gallons
	x 2,5	bushels
WEIGHT		
gram (g)	x 0.04	oz avdp
kilogram (kg)	x 2.2	lb avdp
tonne (t)	x 1.1	short ton
AGRICULTURAL		
litres per hectare (L/ha)	x 0.089	gallons per acre
	x 0.357	quarts per acre
	x 0.71	pints per acre
millilitres per hectare (mL/ha)	x 0.014	fl. oz per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	lb per acre
grams per hectare (g/ha)	x 0.014	oz avdp per acre
plants per hectare (plants/ha)	x 0.405	plants per acre